

CLEAN SET OF ALL PENDING CLAIMS

The clean set of all pending claims is attached.

CLAIMS

21. A high-efficiency switching amplifier amplifying a reference input signal, for digitally processing electric power from a DC supply thereof to a loudspeaker which has a positive terminal and a negative terminal, the switching amplifier comprising:

A first switching power converter comprising bi-directional switches for supplying a positive voltage proportional to the reference input signal to the positive terminal of the loudspeaker when the amplitude of the reference input signal is positive,

A second switching power converter comprising bi-directional switches for supplying a negative voltage proportional to the reference input signal to the negative terminal of the loudspeaker when the amplitude of the reference input signal is negative, and

A PWM controller for controlling the operation of the switches of the first and second power converters in such a manner that when the first power converter is active during the positive portion of the reference input signal, the switches of the second power converter provide a return path for the first power converter's current to and from the loudspeaker; and vice versa, when the second power converter is active during the negative portion of the reference input signal, the switches of the first power converter provide a return path for the second power converter's current to and from the loudspeaker.

22. The switching amplifier of claim 21 wherein the switches of the first and second switching power converters are MOSFETs.

23. The switching amplifier of claim 21 wherein the switches of the first and second switching power converters are of following types: buck converter, forward converter, push-pull converter, half-bridge converter, asymmetrical half-bridge converter, full-bridge converter.

24. The switching amplifier of claim 21 wherein the first and second switching power converters share a transformer and switches coupled to the primary of the transformer.

25. The switching amplifier of claim 21 wherein the transformer is an auto-transformer with a centertap which is coupled to the DC supply via a bi-directional switch which is also controlled by the PWM controller.

26. A high efficiency switching amplifier amplifying a reference input signal, for digitally processing electric power from a DC supply thereof to a loudspeaker, the switching amplifier comprising:

A pulsing power converter comprising bi-directional switches for supplying pulsing voltages at its output,

An H-bridge comprising four bi-directional switches for steering a current into the loudspeaker, the direction of the loudspeaker current being according to the polarity of the reference input signal, the current being caused by the pulsing voltages of the pulsing power converter applied to the H-bridge of switches.

A PWM controller for controlling the operation of the switches of the pulsing power converter and of the H-bridge according to the amplitude and polarity of the reference input signal and according to the amplitude of the DC supply.

Wherein the PWM controller controls timing relationships between the switches of the pulsing power converter and the switches of the H-bridge for minimizing switching losses in the switches of the pulsing power converter.

27. The switching amplifier of claim 26 wherein the pulsing power converter comprises a high-frequency transformer having a primary side and a secondary side for electrical insulation.
28. The switching amplifier of claim 26 wherein the pulsing power converter further comprises a first bi-directional switch for selectively coupling the primary side of the transformer to the DC supply, a second bi-directional switch for selectively coupling the secondary side of the transformer to the H-bridge.
29. The switching amplifier of claim 28 wherein the bi-directional switch is of following types: single switch, half-bridge switch, asymmetrical half-bridge switch, push-pull switch, full-bridge switch.
30. A high efficiency switching amplifier for digitally processing electric power from a DC supply thereof to a loudspeaker, the switching amplifier comprising:
 - a voltage source for supplying a DC voltage,
 - a power modulator for transforming the DC voltage into modulated voltages,
 - at least one transformer for changing the amplitudes of the modulated voltages,
 - a synchronous demodulator for reconstructing the modulated voltages back to audio signal driving a load comprising a loudspeaker,
 - a controller for receiving a reference input signal and a feedback signal to produce digital signals controlling the operation of the power modulator and the synchronous demodulator,
 - wherein the controller controlling the timing of digital signals to both the power modulator and the synchronous demodulator such that they change state substantially synchronously.
31. The switching amplifier of claim 30 wherein the transformer comprises a center-tapped secondary winding which has a first and a second terminals and a center-tapped terminal, and the synchronous demodulator comprises:
 - a first and second bi-directional switches for selectively connecting the first and second terminals of the transformer to a common connection node,

four bi-directional switches in a H-bridge configuration for selectively connecting the center-tapped terminal of the transformer to the common connection node through a load, wherein the four bi-directional switches of the H-bridge provide a bipolar signal to the load connected across the H-bridge.

32. The switching amplifier of claim 31 wherein the common connection node is a ground reference.

33. The switching amplifier of claim 30 wherein the transformer comprises a primary winding and the power modulator comprises bi-directional switches for selectively connecting the primary winding to the DC voltage, the switches being of the following types: forward converter, push-pull converter, half-bridge converter, full-bridge converter.

34. The switching amplifier of claim 30 wherein the transformer comprises a multi-tapped winding which has a first, a second, a fourth, a fifth terminals and a center-tapped terminal, and wherein the synchronous demodulator comprises four switches in a H-bridge configuration for selectively connecting the first and second terminals of the transformer to a ground reference through a load, and wherein the power modulator comprises a push-pull-converter-type modulator.

35. The switching amplifier of claim 34 wherein an additional synchronous switch selectively connects the center-tapped terminal of the transformer to the DC voltage, and wherein the four switches of the synchronous demodulator are MOSFETs.

36. The switching amplifier of claim 30 wherein the transformer comprises a center-tapped secondary winding which has a first and a second terminals and a center-tapped terminal, and the synchronous demodulator comprises:

four switches in a H-bridge configuration for selectively connecting the first and second terminals of the center-tapped secondary winding of the transformer to a common connection node through a load,

a fifth switch for selectively connecting the center-tapped terminals of the transformer to the common connection node,

wherein the four switches of the H-bridge provide a bipolar signal to the load connected across the H-bridge.

37. The switching amplifier of claim 30 wherein the power modulator comprises two switches operating one at a time and driving two transformers, each with a primary winding and a secondary winding, and the synchronous demodulator comprises four switches for selectively connecting the loudspeaker to the secondaries of the transformers one at a time.

38. The switching amplifier of claim 37 wherein the four switches of the synchronous demodulator are arranged to have a common connection node.

39. A method for reducing switching losses of a switching amplifier having a power modulator, a transformer, a synchronous demodulator, and a controller, the method comprising adaptively sending timing signals to the power modulator, and after predetermined delays, sending timing

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signals to the synchronous demodulator, wherein the predetermined delays cause the power modulator to operate in zero current switching.